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(54) A METHOD OF LAUNDERING TEXTILE ARTICLES IN AN AUTOMATIC WASHING MACHINE, AN AGENT FOR USE IN THE METHOD, AND AN AUTOMATIC WASHING MACHINE FOR CARRYING OUT THE METHOD

(71) We, BOSCH-SIEMENS HAUSGERÄTE GMBH, seated in Stuttgart, German Federal Republic, the address for communication being Prannerstrasse 8, 8000 München 2, German Federal Republic, a limited liability company organised under the laws of the German Federal Republic and CHEMISCHE WERKE HÜLS AG, Postfach 1180, 4370 Marl, German Federal Republic, a joint stock company organised under the laws of the German Federal Republic do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

The present invention relates to a method of laundering textile articles in an automatic washing machine, an agent for use in the method, and an automatic washing machine for carrying out the method.

The laundering methods for textile articles hitherto performed in automatic washing machines consume not inconsiderable amounts of water, energy and washing agents and their waste water contributes to an appreciable degree to environmental pollution.

In the hitherto known laundering methods for heavy and white laundry, conventional commercial washing powder is inserted, for each washing process, in the chambers provided therefor in a washing machine. According to the customary instructions of the washing agent manufacturer, about 140 grams of washing powder is provided for each of the pre-wash and the main wash (i.e. in a washing machine for 4 kilograms dry laundry with about 20 litres of washing solution, about 7 grams per litre in the pre-wash and about 7 grams per litre in the main wash). During the pre-wash process, the solution is heated up to about 50°C and, in some cases, the washing drum continues to move with a reversing motion. Thereafter, the washing solution is pumped away, fresh water is added, 140 grams of washing powder is rinsed in anew out of the storage chamber (together with the remainder from the pre-wash, about 10 grams per litre) and the main wash operation is carried out, in which usually the solution is heated to about 90 to 95°C with a reversing motion of the drum and the drum continues to move for 10 to 15 minutes at this temperature. Subsequently, a higher bath ratio is produced by topping-up with fresh water and the laundry is rinsed in up to 7 rinsing operations each lasting 2 to 5 minutes, the water being changed for each operation and the residual washing agent and the dispersed dirt being removed by each change. To obtain soft laundry, a soft rinsing compound may additionally be added to the last rinsing bath.

Known methods of laundering of that kind are generally employed in an automatic washing machine, which has a drum serving as a washing-container and washing actuator and which is rotatably and horizontally journalled in a solution container. An electric motor is generally used to drive the drum.

Such washing machines usually have a so-called rinse-in bowl with at least two chambers which are filled by the user with the required quantity of conventional commercial washing powder before starting the washing process. With multi-chamber rinse-in bowls, one of the chambers is usually provided for a conventional soft rinse agent. The chambers of the

rinse-in bowls are connected, on the one hand, through electrically controlled valves with a fresh water connection of the machine and, on the other hand, with a feed channel leading to the solution container.

The known automatic washing machine further contains a programme selection switch for setting the desired programme according to the nature of the laundry and the dirtiness thereof, and a programme-control device in which, by mechanical and/or electrical means, the corresponding wash programmes are stored in such a way that in the cycle of operation of the machine the functions of water supply, heating, laundry movement and pumping away are controlled in the desired sequence. These functions are additionally influenced by temperature and water level measuring devices.

For the removal of fluid no longer required in the solution container, an outlet opening is generally provided at its lowest point and opens out into a waste-pipe or outlet by way of a fluid pump and a rising duct.

The performance of the known washing method for textile articles in an automatic washing machine is linked with the use of conventional commercially-available packaged washing powders. These washing powders consist principally of the following effective substances: active washing components, complex alkali phosphates as builder substances, alkali perborates as bleaching agents, silicates as an alkali carrier, and bleaching agent stabilisers.

Although the conventional washing agents in packaged form introduced at the beginning of the washing process have a good washing performance, their use, however, implies some disadvantages in the hitherto known washing processes performed in washing machines.

Thus, it is usual for the content of complex phosphate in the packaged washing agents to be set so high that it is appropriate for the regions of high water hardness (about 20° German Hardness).

According to statistics, only about 60% of the households in the German Federal Republic wash with water of over 15° German Hardness (SÖFW 20/1961, see pages 629 to 637, H. Oxe), which means that about 40% of German households are located in pronounced soft water regions. Consequently, washing in such households is carried out either with an excess quantity of phosphates, leading to unnecessary consumption of effective substances and additional environmental pollution, or, if the dose recommendations for regions of lower water hardness are adhered to, the washing methods are operated with an underdose of detergents and unclean laundry results.

Moreover, although the manufacturers of washing agents give dose recommendations by printing on the packages, there is according to general experience always a tendency towards an overdose of the washing agent when added by hand, which results in pollution of the environment.

Furthermore, the statistics indicate (SÖFW 19/1974, page 491 in connection with the "Handbuch für den Textilingenieur und Textilpraktiker", Part I 61, page 21 "Grundlagen der Textilveredlung") that, measured as a proportion of the quantity of so-called fine laundry actually present, fine washing agents are used to a considerably smaller degree. Fine laundry is thus in practice, for the predominant part, washed with coarse washing agents.

In the known washing methods at washing temperatures up to 60°C, the bleaching agents (perborates) and their stabilisers which together are present in the complete washing agent in an amount of up to about 30%, are not utilised, since they only become effective at temperatures far above 60°C. Thus, in the case of fine laundry there is a further excessive use of effective substances and additional pollution of the environment.

It is furthermore to be considered that according to general washing practices, a complete washing agent is also used in the pre-wash operation in most households. Thus, in the pre-wash as well, the high proportion of bleaching agent in the complete washing agent is not brought into effect due to the temperature being too low, and leaves the washing machine without being used. In this case, also, a disproportionate use of effective substances is carried out and the environment is subjected to additional pollution.

Even when washing in temperature ranges up to boiling point, a considerable proportion of the perborates present goes out unused in the waste water.

One of the reasons for this is that the manufacturers of complete washing agents must set the proportion of bleaching agents to deal with the greatest possible soiling. As can be gathered from the literature, (Trace Elements in the Environment, Advances in Chemistry Series 123, page 135) a relatively high boron content in streams can have an unfavourable effect on the growth of some plants.

It must also be considered that the manufacturer of a powdery complete washing agent generally uses alkali perborates as the bleaching agent, since the other known bleaching agents are less well suited to this application.

The employment of alkali perborates, however, entails further disadvantages in addition

to those cited above.

For one thing, it is imperative for the purpose of bleaching to heat the washing solution well above 60°C, since the decomposition of the perborates at a moderate speed begins only above 60°C and so proceeds at about 90 to 95°C that an effective bleaching process is made possible. This circumstance leads to the performance of the washing process for white laundry at 95°C, since a washed unbleached white laundry will not be considered to be clean.

For the actual washing operation of the laundry, i.e. the dissolving of the dirt and the dispersion thereof so finely that redisposition on the washed textile fabrics does not take place, a maximum temperature of the solution of 60°C would suffice.

The use of complete washing agents in the washing with bleaching thus requires a higher washing temperature to be used. Therefore, a high energy consumption, which is disproportionate in comparison with the washing effect, is required. Finally, the high water consumption of the known washing methods must be considered.

The washing machine manufacturer sees himself as bound to incorporate so many rinsing operations in the automatic course of the conventional washing process that residual alkali content can act neither injuriously to tissue nor irritatingly to the skin, particularly in the case of the frequently occurring overdose of the washing agent when added by hand.

According to a first aspect of the present invention, there is provided a method of laundering textile articles in an automatic washing machine, comprising the steps of adding water to an automatic washing machine charged with textile articles to provide a wash having a weight ratio of textile articles to washing solution of 1:4 to 1:30, withdrawing from respective storage means metered quantities of effective substances or combinations of effective substances in pumpable form, the effective substances comprising 0.5 to 3.5 grams of active washing substances per litre of the washing solution and 2.0 to 6.5 grams of builder substances per litre of the washing solution, adding the metered quantities to the washing solution before or during the washing process, agitating the textile articles in the washing solution during an active washing time of up to 50 minutes, removing the washing solution from the machine after the active washing time, and then rinsing the textile articles 2 to 5 times.

Preferably, the method comprises the addition of water and effective substances to the automatic washing machine, relative motion of the laundry to the washing solution, pumping away of the solution, and then carrying out of the rinsing operations, the following separately stored effective substances or combinations of effective substances being fed metered in pumpable form before or during laundering:

1. Active washing substances
2. Builder substances
3. Optionally a stabilised bleaching agent and
4. Optionally a catalyst accelerating the bleaching process
5. Optionally an organic acid
6. Optionally a soft rinse agent

in which, after input of the textile articles to be treated and during or after addition of water with setting to a solution ratio of 1:4 to 1:30, 0.5 to 3.5 grams of active washing substances per litre of washing solution and 2 to 6.5 grams of builder substances per litre of washing solution are supplied, in a given case set to the washing temperature, the laundry during an active washing time of up to 50 minutes is further moved and 2 to 5 rinsing operations are carried out in a known manner.

An expedient embodiment of the method comprises that in a first stage of the washing process, 0.5 to 1.5 grams of active washing substances as well as, in a given case, 1 to 3 grams of builder substances are added per litre of washing solution, the solution is set to a temperature of up to 60°C, while the laundry is moved relative to the solution, the solution is then pumped away, fresh water added up to the indicated solution ratio and in a second stage of the washing process 0.5 to 2.0 grams of the active washing substances per litre of washing solution and 1 to 3.5 grams of builder substances are added per litre of washing solution, the washing solution is brought to a temperature of up to about 95°C and the laundry continued to be moved relatively to the solution during an active washing time of up to 50 minutes. In embodiment of the method according to the invention, the second stage of the washing process is carried out at a temperature of up to 60°C. Preferably, during the washing process, 0.1 to 0.5 grams of a stabilised bleaching agent per litre of washing solution are added.

In another embodiment of the method, a catalyst accelerating the decomposition of the bleaching agent is added.

In a further embodiment of the method 0.02 to 0.1 gram of one or more organic acids per litre of rinsing solution are fed in during a rinsing operation. Expediently, 0.1 to 0.5 grams

of a soft rinsing agent per litre of rinsing solution are added during a rinsing operation.

According to a second aspect of the present invention there is provided an agent for use in the method according to the first aspect of the invention, the agent comprising a combination of effective substances in pumpable form, the effective substances being separate from one another in packages suitable for the household and comprising at least an active washing substance and a builder substance in amounts of respectively 0.5 to 3.5 parts by weight and 2.0 to 6.5 parts be weight, the active washing substance in the combination comprising:

20 to 25% by weight of linear chain alkylbenzolsulphonate-Na-salt (C_{10} to C_{13}), 100%

1.2 to 1.8% by weight of toluolsulphonate-Na-salt, 100%
8.0 to 9.5% by weight of hardened tallow-fat-acid-Na-soap,
12.5 to 16.5% by weight of tallow-fat alcohol with 11 ethylene oxide,
9.5 to 13.0% by weight of isopropanol, and
0.3 to 0.5% by weight of NaOH, the remainder being water with usual impurities and of 1 to 14° German Hardness.

According to a third aspect of the present invention there is provided an agent for use in the method according to the first aspect of the invention, the agent comprising a combination of effective substances in pumpable form, the effective substances being separate from one another in packages suitable for the household and comprising at least an active washing substance and a builder substance in amounts of respectively 0.5 to 3.5 parts by weight and 2.0 to 6.5 parts by weight, the active washing substance in the combination comprising:

13.0 to 17.0% by weight of olefinsulphonate-Na-salt (C_{16} - C_{18}), 100%
30.0 to 35.0% by weight of oleyl alcohol + 10 ethyleneoxide + 3 propyleneoxide,
2.0 to 4.0% by weight of hardened tallow-fat-acid-Na-soap, and
9.0 to 11.0% by weight of isopropanol, the remainder being water with usual impurities and of 1 to 14° German Hardness.

Preferably, the agent is characterised by a combination of the following effective substances in pumpable form:

1. Active washing substances
2. builder substances
3. optionally a stabilised bleaching agent and
4. optionally a catalyst accelerating the bleaching process
5. optionally an organic acid
6. optionally a soft rinsing agent

in which the effective substances concerned are preset separate from one another in packages suitable for the household. The agent may optionally comprise:

0.1 to 0.5 parts by weight of stabilised bleaching agent
and
a quantity, at least stoichiometrical in relation to the bleaching agent, of a catalyst accelerating the bleaching process,
0.02 to 0.1 parts by weight of an organic acid, and
0.1 to 0.5 parts by weight of a soft rinsing agent.

The builder substance is suitably added in the following proportions:

a) 35.0 to 40.0 percent by weight of potassium tripolyphosphate,
0.8 to 1.8 percent by weight of sodium silicate (waterglass 100%),
0.5 to 0.9 percent by weight of NaOH, and
up to 100.0 percent by weight of water of 0 to 14° German Hardness,
or
b) 44.0 to 47.0 percent by weight Na-nitrilotricetate,
0.8 to 1.6 percent by weight of sodium silicate (waterglass.100%),
1.0 to 2.0 percent by weight of NaOH, and
up to 100.0 percent by weight of water of 0 to 14° German Hardness

The bleaching agent is advantageously present in the following proportions:

5.0 to 10.0 percent by weight of hydrogen peroxide 100%,
0.1 to 0.15 percent by weight of dipicolinic acid, and
up to 100.0 percent by weight of water of 0 to 14° German Hardness.

N-acetyl-caprolactam is expediently present as catalyst accelerating the bleaching process.

The organic acid is advantageously present in the following proportions:

2.0 percent by weight of citric acid.

0.2 percent by weight of lactic acid,
0.2 percent by weight of acetic acid, and
up to 100 percent by weight of water of 0 to 14° German Hardness.

The expression up to 100 percent by weight of water of 0 to 14° German Hardness used in relation to any composition in the specification is to be understood as signifying that such water constitutes the balance of such composition and may contain usual impurities.

An overdosage of complex phosphates or an underdose of other active substances needed for the washing can easily be avoided in a method exemplifying the invention, since the quantity of builder substances or phosphates to be added can be adjusted to the hardness of the water of the region concerned, in accordance with the manufacturer's instructions, when setting up the machine.

Thereby, the unnecessary consumption of active substances and the pollution of the environment connected therewith, originating from the tendency to overdose phosphate in soft-water regions, is avoided. On the other hand, an underdose of the other substances necessary to the washing process is also avoided, such an underdose previously taking place when, in the case of packaged complete washing agents, less of the complete washing agent was used in accordance with the manufacturer's dosing recommendations in respect of low hardness of water.

Since the active substances of the washing agent are stored separately and are fed separately to the washing solution in pumpable form, it is possible to use bleaching systems, stabilised bleaching agents and catalysts, which are already fully effective at comparatively low temperatures, namely also those of the fine wash operation.

Consequently, with a method exemplifying the invention, it is possible to subject the fine wash as well to a bleaching operation.

Moreover, the large ballast of perborate hitherto present in a fine washing operation is no longer dragged along and can thus no longer cause pollution of the environment. In a method exemplifying the invention, hydrogen peroxide is expediently employed as a bleaching agent. This decomposes without leaving a residue, whilst the stabiliser and catalyst are present in comparatively small quantities, so that they cannot cause pollution of the environment.

Due to the separate feeding of the individual effective substances of the washing agent, it is also possible, in contrast to the current practice of using a complete washing agent for the pre-wash as well, to completely dispense with an added amount of a bleaching agent. Thus, compared with the prior art methods, large quantities of effective substances are saved and, at the same time, the environment is preserved from pollution by these substances.

To this is added, that although the selection of the washing programme in respect of strongly, moderately and lightly soiled washing may be undertaken by hand in a method exemplifying the invention, the requisite quantity of effective substances of the washing agent for the envisaged programme is, however, fixedly set in the washing machine. This avoids overdosage of effective substances, which would otherwise lead to pollution of the environment.

A further advantage of a method exemplifying the invention is that a bleaching system, which is effective at comparatively low temperatures, can be employed, and the washing operation for coarse and white washing is thus no longer constrained to be performed at 90 to 95°C. It suffices to wash even coarse and white articles at 60°C, which makes possible a considerable saving of energy (see Table 2).

In addition, by dispensing with perborates in a method exemplifying to the invention - perborates cannot be fed into the washing process in suitable concentrations by pumping - danger of a further rise in the boron-content in streams can be eliminated.

As a further advantage, there may be some saving of water, since firstly an overdose of washing agents is avoided and secondly the residual alkali content in the laundry can be absorbed by the addition of organic acids to the rinsing operation or an acidic soft-rinsing agent. According to Tables 1, 2 and 3, the saving in water can amount to about 15%.

As is to be gathered from Tables 2 and 3, the overall saving in time and energy in the washing of coarse and white laundry by a method exemplifying the invention can - by dispensing with an unnecessarily high washing temperature (60°C instead of 95°C) - amount to about 30% in each case. As is evident from the following examples, an equally good washing result is obtained in that case as by washing at 95°C.

With the method according to the first aspect of the invention and with use of the agent according to the second aspect of the invention, it may thus be possible to save time, energy, water and effective substances in the washing of laundry in a washing machine, and to reduce environmental pollution.

According to a third aspect of the present invention there is provided an automatic washing machine for carrying out the method according to the first aspect of the invention, the machine comprising a housing, washing-programme control equipment, at least one

valve-controlled fresh water feed duct, a solution pump, a solution container, a plurality of metering devices, which are arranged in the housing, are selectively controllable by the programme-control equipment and which are each adapted to meter a respective one of a corresponding plurality of separate effective substances or combinations of effective substances of an agent, each metering device being provided with an inlet directly connected with an outlet of a container for the respective effective substance or combination and provided with an outlet directly opening into a common premixing channel connected with the solution container, and drive means so drivingly couplable to the metering devices as to drive any one or any combination of the devices.

Preferably, the washing machine comprises a programme-control device, at least one valve-controlled fresh water feed duct, a solution pump, a plurality of metering devices for the effective substance of the washing agent, the devices being arranged in a housing of the machine, being controllable by the programme-control equipment and corresponding in number to the used effective substances or combinations of effective substances, the inlets of the devices being directly connected each with a feed connection of one of the same number of effective substance containers and the outlets of the devices opening out into a common pre-mixing channel, which is connected with the washing solution container through a water trap, and drive means with which each metering device is connectable as required. This arrangement allows a very narrowly constructed device, which can, for example in the case of a front-loadable drum-type washing machine, be located in one of the spatial corners above the drum-shaped washing solution container. Due to the connection of all the metering devices to a common pre-mixing channel, on addition of each effective substance of the washing agent all outlets are wetted by water for a sufficiently long time to prevent the occurrence of jelling or crystallisation of the effective substances and clogging of the ducts or duct parts.

Due to the extremely short paths between the effective substance containers and the pre-mixing channels, the metering tolerances in the effective substances of the washing agent are furthermore kept small.

According to a particular embodiment, the effective substance containers are exchangeably arranged in the machine housing, while at the end face turned towards the metering devices and at the lowest point of each effective substance container, a feed connection pointing in the direction of the exchange movement is arranged. In the unused state, the connection is provided with a closure membrane, which is pierced by a hollow pin on the insertion of the effective substance container into the space provided for it for connection with the associated metering device. A ventilating device preventing the exit of air from the container is also provided for each effective substance container. By this arrangement, purchase of new completely closed effective agent containers is possible, the new containers being exchangeable in a simple manner for the emptied containers plugged into the machine, without anyone having to come into contact with the contents of the containers.

Alternatively, the effective substance containers may be fixedly arranged in the machine housing and may each possess a replenishing inlet. A cheaper construction of the receiving device of these containers and of the connecting elements to the metering devices is possible due to the fixed arrangement of the effective substance containers. Furthermore, the manufacturers of effective substances of washing agents are then able to offer the trade the most suitable replenishment container.

The metering devices may comprise gear pumps which are each couplable with a common driving motor through a respective electrically switchable coupling. Gear pumps permit an accurately time-controlled metering of liquids of almost any viscosity. Electrically switchable couplings of such small size are sufficiently quick and keep the cost and complication of the metering devices and - because of the very small control power requirements - of the control devices provided for the control of the metering devices, within tolerable limits.

Since the common pre-mixing channel is connected on the one hand with the pressure side of the solution pump and on the other hand by means of an overflow elbow with the water trap, the danger of jelling or crystallisation of the effective substances of the washing agents at the outlets of the metering devices can be completely eliminated. The overflow elbow prevents flowing away of the water in the pre-mixing channel as soon as the feed from one side ceases. The connection of the pre-mixing channel with the solution pump also permits the addition of an effective substance of the washing agent to the washing solution during any desired phase of the washing process without the already warm washing solution being cooled down by a renewed feed of cold fresh water.

There may be provided a hydraulic jump for preventing the sucking-back of water already fed in, the jump being so arranged that the fresh water feed duct opens directly into the water trap through the jump.

With the washing machine according to the third aspect of the invention, it may be

possibl to process equally well and without additional operating steps all commercially available liquid washing agent substances of almost any viscosity. When replenishing a consumed quantity of any kind of washing agent effective substance employed, leakage of the substance out of the storage container or commercial container, as well as any possibility of contact with this substance, is largely excluded.

Since the method according to the invention can be employed with household washing machines and these are often unused for longer periods, it is of particular advantage that a jelling or crystallisation of washing agent effective substances within their ducts or duct-parts is prevented. The requirements of environmental protection are met due to automatic feeding of the effective substances to the washing machine in such quantities that entrainment of unused washing substances in the waste washing solution may be substantially avoided. This requires accurate metering independent of the pressure of the fresh water duct, and such accuracy may be achieved in the washing machine according to the invention. Furthermore, the washing machine can have the dimensions usual for the household; i.e. the devices for the storage and metering of the washing agent effective substances can be built into a washing machine housing with the conventional dimensions of 60 x 60 centimetres base surface and 85 centimetres height.

As active washing substances, which are constituents of the agent according to the second or third aspect of the present invention and which are, in accordance with the method of the invention, fed metered to the solution in pumpable form before or during laundering, known anion-active, cation-active and non-ion producing detergents such as betaines, which are usually employed in washing textiles, are suitable. Suitable substances are, for example, alkylbenzolsulphonates such as straight-chain alkali alkylbenzolsulfonate with 10 to 14 c-atoms in the alkyl chain in which the maximum lies at c_{12}, alkali-alkanesulphonate with a chain-length of 14 to 18 c-atoms, alkali-olefinsulphonate from α-olefines with 12 to 20 c-atoms chain length, alkali slats of the sulphuric acid ester of higher molecular alcohols with 10 to 20 carbon atoms in the alkyl chain or alkali salts of natural or synthetic fatty acids with 10 to 22 carbon atoms, esters of the fatty acid alkali salts and carboxylates of fatty alcohol oxethylates.

Suitable non-ion producing detergents are, for example, oxethylates of natural or synthetic fatty alcohols containing 10 to 20 carbon atoms, fatty acids of natural or synthetic origin containing 12 to 18 carbon atoms or fatty acid amides or alkyl phenols containing from 8 to 10 carbon atoms in the alkyl chain. The oxethyl content of the oxethylates used is such that the hydrophilic-hydrophobic balance important for detergents is observed. The bonds may also be propoxylated. To be mentioned by way of example are tallow-fat alcohol oxalkylated with 8 to 12 mols ethylene oxide and 2 to 4 mols propylene oxide, and oleyl alcohol oxalkylated with 8 to 12 mols ethylene oxide and 2 to 4 mols propylene oxide, which may also be applied in mixture.

To achieve a better washing effect, non-ionogenic detergents are generally used together with the above-mentioned anion active detergents in proportions by weight known in the washing technology. Expediently, there are added the usual foam-suppressing substances, for example, alkali salts of hardened tallow-fat acids with 4 to 6% behenic acid in the fatty acid combination and a titer of 39 to 41°C fatty alcohol with 12 to 18 c-atoms and their lower oxethylated derivatives, derivatives of melamine or terminally blocked fatty alcohol ethylates. If alkyl benzolsulfonates or alkanesulfonates are employed as anion-active substances, it is recommended that hydrotropic substances such as short-chain alkyl benzolsulphonates, for example, alkali-toluolsulphonate or alkali-cumolsulphonate, are added as a dissolving agent in the proportion of 0.5 to 10 per cent by weight referred to the anion-active substance. Small quantities of low molecular alcohols such as 8 to 15% isopropanol can also improve the solubility of the detergent mixture.

In order that the active washing substance and any additives added thereto, for example, clarifiers, perfume, dye, preservative, are present in pumpable form, they contain appropriate quantities of water, in general 30 to 60 percent by weight referred to the overall pumpable solution. If enzymes are to be used for improvement of the cleansing effect, a pumpable mixture of active washing substances and enzymes of a water-free base, such as perhaps that of glycols or alcohols, is necessary. Mixtures of active washing substances consisting of non-ionic and cationic detergents can also be used to obtain particular effects.

Usable as builder substances are known compounds with complex-forming properties like tripolyphosphates, pyrophosphates, nitrogenous polycarbon acids, polycarbon acids, carboxamides, tensides with builder properties and inorganic water-soluble salts, and also heterogeneous organic and inorganic builders of the alkali aluminium silicate type or polyacrylic acids.

In order to impart to the washing solution a certain alkalinity promoting the cleansing effect, one will admix 2 to 8% by weight (referred to the quantity of builder substance) of alkalis such as NaOH, KOH or amines, together with 8 to 15% by weight of alkali silicates,

to the builder substance. In order for the builder substances to be present in pumpable form, they contain appropriate quantities of water, in general 40 to 60% by weight referred to the overall pumpable solution.

Preferably, the bleaching agent is H_2O_2, which provided with a stabiliser is suitably retained in store in the washing machine as an approximately 7% aqueous solution. Lower concentrations can also be used. Suitable as stabilisers are organic acids such as, for example, pyridine carbon acids, especially dipicolinic acid. Generally, the bleaching agent is added after attainment of the washing temperature. A catalyst accelerating the bleaching process is, for example, N-acetyl-caprolactam. Also suitable are acylating agents like N-acylamide, acylhydroxy amines or N-acylsulphonamides, these compounds generally being added in stoichiometrical quantities.

Formic acid, acetic acid, lactic acid or citric acid, for example, can be used as organic acids for acidulation in the rinsing operation.

As soft rinsing agents, known cation-active substances can be used, as well as cation-active-like products such as, for example, condensation products of monobasic organic acids with at least 16 to 18 C-atoms and an amine such as for example N-oxyethylpropanediamine. It is expedient to mix the soft rinsing agent with one or more organic acids, for example acetic acid, lactic acid, citric acid in quantities of 15 to 25 percent by weight (referred to the soft rinsing agent). For improvement of the solubility, glycols or low molecular alcohols can be added. Furthermore, the soft rinsing agent can contain conventional bacteriostatic and/or bactericidal additives as well as optical clarifiers.

The formulations of the above-mentioned substances must be of such a nature that their pumpability is retained even during long storage.

With respect to the amounts of active washing substances to be added, expediently, when washing lightly soiled laundry in the one-solution process, 0.5 to 2.5 grams of active washing substances are added per litre, with medium soiled laundry 1.0 to 1.5 grams per litre and with heavily soiled laundry 2.0 to 3.5 grams per litre of the washing solution. In the two-solution operation, the total quantity of active washing substances to be added is added in parts.

A similar procedure is used with respect to the quantities of builder substances to be used, i.e. when washing slightly soiled laundry in the one-solution process, 2.0 to 3.5 grams of builder substances per litre of the washing solution are used, with medium soiled laundry 3.0 to 4.5 grams per litre are used, and with heavily soiled laundry 4.0 to 6.5 grams per litre are used. In the two-solution process, the quantity of builder substances to be used in total is added in parts.

In the washing of coarse and white laundry, a solution ratio of 1:4 to 1:5 will be used, whilst for easily cared-for laundry there is set a solution ratio of 1:10 to 1:25, and 1:20 to 1:30 for wool.

With special constructions of machines, it would also be feasible to use reduced quantities of water referred to the laundry.

In the use of complex phosphates as builder substances in soft-water regions (0 to 7 German Hardness), there is chosen a ratio of phosphate to active washing substances of 1:1 to 1.5:1, in regions of medium hardness of water (7 to 14 German Hardness) a ratio of phosphate to active washing substances of 1:1 to 2.5:1, and in hard water regions (from 14 German Hardness) a ratio of phosphate to active washing substances of 2:1 to 3:3. The setting of this quantity ratio is expediently undertaken during the installation of the washing machine. Suitable equipment for this purpose in an automatic washing machine is described by way of example with reference to Figures 7 and 8.

The washing temperature, in the case of coarse and white laundry can be 90° to boiling point, it being advantageous to operate at 60°C to save energy and time. When washing coloured articles, the process is preferably carried out at 30 to 60°C, whilst fine laundry and easily cared-for laundry are preferably treated at 30 to 60°C.

The method according to the invention can *inter alia* be utilised in laundry-parlours and in coin-operated machines.

The following examples and comparative examples illustrates the method according to the invention:

Composition of the combinations of effective substances employed

1. *Active washing substances with additives*
Effective substance combination A_1:
22.5 percent by weight of straight-chain alkyl benzosulphonate$^+$ Na-salt 100%
1.4 percent by weight of toluolsulphonate-Na-salt 100%
9.0 percent by weight of hardened tallow-fat acid-Na-soap
14.5 percent by weight of tallow-fat alcohol with 11 ethylene oxide
11.0 percent by weight of isopropanol
0.4 percent by weight of NaOH
up to 100.0 percent by weight of water of 12° German Hardness
+ 5% C_{10}, 15% C_{11}, 45% C_{12}, 35% C_{13}.
Effective substance combination A_2:
15.2 percent by weight of olefin sulphonate-Na-salt 100% (C-chain length $C_{16} - C_{18}$)
33.0 percent by weight of oleyl alcohol + 10 ethylene oxide + 3 propyleneoxide
3.0 percent by weight of hardened tallow-fat acid-Na-soap
10.0 percent by weight of isopropanol
up to 100.0 percent by weight of water of 12° German Hardness

2. *Builder substances*
Effective substance combination B_1:
37.8 percent by weight of potassium tripolyphosphate
1.5 percent by weight of sodium silicate (waterglass 100%)
0.7 percent by weight of NaOH
up to 100.0 percent by weight of water of 12° German Hardness
Effective substance combination B_2:
46.0 percent by weight of NTA (Trilon a)
1.2 percent by weight of sodium silicate (waterglass 100%)
1.5 percent by weight of NaOH
up to 100.0 percent by weight of water of 12° German Hardness

3. *Stabilised bleaching agent*
Effective substance combination C;
7.0 percent by weight of hydrogen peroxide 100%
0.1 percent by weight of dipicolinic acid
up to 100.0 percent by weight of water of 12° German Hardness

4. *Catalyst accelerating the bleaching process*
Effective substance D:
100.0 percent by weight of N-acetyl-caprolactam

5. *Organic acid*
Effective substance combination E:
2.0 percent by weight of citric acid
0.2 percent by weight of lactic acid
0.2 percent by weight of acetic acid
up to 100.0 percent by weight of water of 12° German Hardness

6. *Soft rinse agent*
Effective substance combination F:
6.0 percent by weight of condensation product of stearic acid and N-oxethylpropanediamine
3.0 percent by weight of 1,2-propylene glycol
1.0 percent by weight of citric acid
0.1 percent by weight of lactic acid
0.1 percent by weight of acetic acid
up to 100.0 percent by weight of water of 12° German Hardness

Concerning the proving trials carried out, the following is to be noted:

The expert knows about the difficulties of recording numerically the washing-strength and/or cleaning capability of a washing process and/or effective substance or combination of effective substances suitable for the washing. The diversity in kind and the washability of the dirt as well as of, for example, the kind of the fibre and the textile surface, contain many uncertain factors, so that according to the present state of knowledge, several methods of measurement, applied alongside one another if desired, lead to the optimum assessment:

1. For white boiled laundry, the evaluation will be undertaken by a trained circle of persons, while care is taken that approximately equally soiled laundry articles of various professional and social strata are concerned. The laundry will be judged by the same circle of persons before and after the washing operation. Merely the degree of the absolute cleanliness will be ascertained and the number of the clean laundry articles stated under "evaluation" indicated. It will in that case be evalutated strictly according to "clean" and "not clean"; even the smallest spots and shadings on large laundry pieces such as, for example, bed-coverings will occasion the judgment "not clean". Following the evaluation is the statement in each case of the percentage of clean articles. The larger the percentage, the greater the success of the washing. Each trial is repeated 25 times.

For fine and wool laundry articles as well as mens' shirts, a visual judgment will likewise be undertaken by a larger circle of persons. In the case of shirts, collars and cuffs will be judged particularly. In these cases, no percentage valuation will be carried out, but the appearance will be judged by giving the remarks "very good", "good", "almost good" and "satisfactory".

2. Besides these criteria for the valuation of the washing result, the primary washing effect is tested according to DIN 44983 on artificially soiled test fabrics of the Laundry Research Krefeld, registered association, (WFK) and of the Federal Material-testing Institute (Empa), St. Gallen. The secondary washing effects were measured on cotton fabrics dyed immedial green for the determination of the bleaching intensity of the washing process, and on standard cotton strips and towel fabrics for the determination of the degree of whiteness, greying, damage factor, ash content and calcium content.

Example 1

After filling the machine with 4 kilograms of soiled household laundry as well as a few test cloths and setting of a solution ratio of approximately 1:5 with water of 18° German Hardness, 24grams of active washing substances in the form of the combination of effective substances A1 and 70 grams of potassium tripolyphosphate in the form of the combination of effective substances B_1 were added in the first stage. It was then heated to 40 to 45°C while the drum was rotated with reversing. Thereafter, the washing solution was pumped away and fresh water of 18° German Hardness introduced to provide a solution ratio of about 1:5. Then, in the second stage, 20 grams of active washing substances (effective substance combination A_1) and 65 grams of K-tripolyphosphate (effective substance combination B_1) were introduced, the solution heated up to 95°C and the drum rotated with reversing during a further 20 minutes. After reaching the maximum washing temperature in the second stage, 2.0 grams of H_2O_2 100%, in the form of the H_2O_2 solution stabilised with 0.1 percent by weight dipicolinic acid (effective substance combination C) were introduced. After the expiry of the washing-time, it was filled up with fresh water to the rinsing level and rinsed 4 times with fresh water with a solution ratio of approximately 1:6. Added to the last rinsing operation were 3 grams of a condensation product of stearic acid and N-oxethylpropanediamine, which had been set to a pH-value of 2.2 with 1 percent by weight of citric acid, 0.1 percent by weight of lactic acid and 0.1 percent by weight of acetic acid, in the form of the effective substance combination F.

Comparative Example 1

For comparison, the following known method was carried out in the drum of a commercially conventional washing machine:

4 kilogram of soiled household laundry and various test cloths were put into the washing machine and, by switching to the "boiling wash" programme, a solution ratio of approximately 1:5 was set up with water of 18° German Hardness. At the same time, 135 grams of a commercially conventional packaged household washing powder for boiling wash was poured into the first chamber, provided for it, of the rinse-in bowl according to the instructions on the packet of washing powder.

The washing solution was heated up to about 45°C and in that case washed for 20 minutes with a reversing motion of the drum. The washing solution was then pumped away, once more set to a solution ratio of about 1:5 with fresh water of 18° German Hardness, and, for the second washing stage, a further 135 grams of the above-mentioned washing powder were rinsed in through the second chamber of the rinse-in bowl. The washing solution was

heated to 95°C and the drum further moved with a reversing motion for 20 minutes at this temperature. Thereafter, fresh water was added to provide a solution ratio of about 1:6 for 5 rinsing operations and 60 millilitres of a commercially conventional soft-rinse agent were introduced into the last rinsing bath.

The evaluation of the washing result took place as already described:

Visual evaluation of the laundry:

Method exemplifying the invention = 85% ± 1.2

Prior art method = 84% ± 1.9

The evaluation of the different test cloths was undertaken as already described and yielded in tabular form:

Testing according to DIN 44 983

Jointly washed test fabric		(Method exemplifying the invention)	(Prior Art Method)
WFK (Laundry Research, Krefeld)	:	67.8± 1.0	72.8 ± 0.4
EMPA (Federal Material Testing Institute, St. Gallen	:	52.3 ± 0.9	50.3 ± 0.4
Bleaching intensity	:	33.3	46.1
Greying Wo Standard	:	2.8	0.4
Greying Wo Towelling	:	5.8	4.6
Degree of whiteness after 25 washings	:	105.2	103.0
Damage factor	:	0.1	0.2
Ash standard	:	0.2%	0.2%
Ash towelling	:	0.2%	0.3%
Rinse alkalinity	:	0.1	0.5

Deposition of Ca, measured by flame photometry
(Tested after 5, 10, 15, 20 and 25 washings)

Method examplifying the invention:	Washing operation	5	10	15	20	25
	Ca ppm	630	650	610	750	850
Prior art method		5	10	15	20	25
	Ca ppm	650	630	615	730	900

It is evident from the results that, with the method exemplifying the first aspect of the invention and with use of an agent embodying the second aspect of the invention, and in spite of a saving of effective substances and lesser pollution of the environment, equally good washing results are to be obtained as with the prior art method and agent.

Example 2

As in Example 1, 4 kilograms of soiled household laundry were placed in the washing machine, the solution ratio was adjusted to approximately 1:5 with water of 18° German Hardness and 24 grams of active washing substances were added in the first stage in the form of the effective substance combination A_1 as well as 70 grams of potassium tripolyphosphate in the form of effective substance combination B_1. The washing solution was heated to 45°C and the drum in that case rotated with a reversing motion. Thereafter, the solution was pumped away and fresh water introduced to provide a solution ratio of approximately 1:5. In the second stage, the metering was undertaken with 20 grams of active washing substances and 65 grams of K-tripolyphosphate in the same manner as in Example 1, the solution, however, being heated to a washing temperature of only 60°C and the drum being further rotated with a reversing motion in a prolonged active washing time of 40 minutes. Otherwise, the procedure was as described in Example 1. In addition, 7 grams of N-acetyl-caprolactam were introduced together with H_2O_2 solution as an agent accelerating the bleaching process.

Comparative Example 2

In the trial performed for comparison, soiled household laundry was washed as in comparative Example 1, but at 60°C with the active washing time prolonged to 40 minutes.

The evaluation of these washing trials led to the following results:

Visual evaluation of the laundry:

Method exemplifying the invention = 82% ± 2.2

Prior art method = 61% ± 3.5

Testing according to DIN 44 983

Jointly-washed test fabric		(Method exemplifying the invention)	(Prior Art Method)
WFK	:	59.5 ± 1.1	62.2 ± 1.2
EMPA	:	43.1 ± 0.9	44.7 ± 0.6
Bleaching intensity	:	54.1	18.7
Greying Wo standard	:	1.5	1.4
Greying Wo towelling	:	6.4	7.2
Degree of whiteness after 25 washings	:	102.8	105.4
Damage factor	:	0.0	0.1
Ash standard	:	0.1%	0.6%
Ash towelling	:	0.2%	0.3%
Rinse alkalinity	:	0.1	0.4

Deposition of Ca, measured by flame photometry
(Tested after 5, 10, 15, 20 and 25 washings)

Method exemplifying the invention:

Washing operation	5	10	15	20	25
Ca ppm	660	730	550	610	550

Prior art method:

	5	10	15	20	25
Ca ppm	610	780	600	650	710

On the evidence of the result of this test, approximately equally good values of the visual evaluation were obtained by the method exemplifying the invention with soiled household laundry and with a temperature of only 60°C, as with a 95°C wash carried out by the prior art method.

A 60°C wash according to the prior art method cannot, however, be carried out, since no satisfactory results in respect of the removal of spots are obtainable. As already set forth, the perborates contained in the washing agents of the prior art agent do not become effective at 60°C. In the present comparative example, the proportion of spotted laundry amounted to about 40%. According to the structure of the household, this proportion and consequently the percentage of unsatisfactory laundry, can be considerably higher. Thus, the method exemplifying and the agent embodying the invention open up the possibility of a considerable saving of time, energy (approximately 30%) and water (15%) in the washing of soiled household laundry (compare Table 2).

Example 3

The same procedure was carried out as in Example 2, i.e. 4 kilograms of soiled household laundry were washed by the two washing solution process with the same metering of active washing substances and builder substances at the same washing temperature, but, as distinct from Example 2, the active washing time in the second stage amounted to only 20 minutes, i.e. the prolonged active washing time of the Example 2 was not applied. The rest of the procedure was as described in Example 1.

The evaluation of this washing trial led to the following results:

Evaluation according to DIN 44 983.

Method exemplifying the invention = 77% ± 3.2

Testing according to DIN 44 983

Jointly washed test fabric	Method exemplifying the invention
WFK	58.5 ± 1.1
EMPA	37.3 ± 1.2
Bleaching intensity	49.3
Greying Wo standard	1.2
Greying Wo towelling	6.1
Degree of whiteness after 25 washings	103.4
Damage factor	0.3
Ash standard	0.2%
Ash towelling	0.2%
Rinse alkalinity	0.1

As the values show, the washing method exemplifying the invention can be performed, even at 60°C and with the usual active washing time, with satisfactory washing results and excellent spot removal.

A washing process at 60°C according to the prior art method does not lead to satisfactory removal of spots and must thus be regarded as unacceptable.

Example 4

About 1 kilogram = 5 articles of partially heavily soiled non-iron mens' shirts (cotton/polyester in ratio of 1:1) were placed in the washing machine and thereafter a solution ratio of about 1:25 was set with water of 18° German Hardness. In the first stage of the washing process, 25 grams of active washing substances in the form of effective substance combination A_2 and 80 grams of nitrilo-triacetate in the form of effective substance combination B_2 were added, then heated to 30°C and the drum rotated with a reversing motion. Thereafter, the solution was pumped away, the drum filled with fresh water, also of 18° German Hardness, to provide a solution ratio of 1:22 and, in the second stage, charged with 25 grams of active washing substances in the form of effective substance combination A_2 and 80 grams of nitrilotriacetate in the form of effective substance combination B_2 and, after the solution had been heated to 60°C, rotated with a reversing motion for a further 10 minutes. After reaching the washing temperature in the second stage, 2.0 grams of H_2O_2 100% in the form of H_2O_2 solution stabilised with 0.1 percent by weight of dipicolinic acid introduced in the form of effective substance combination C as well as 12 grams of N-acetyl-caprolactam as an agent accelerating the bleaching process. After expiry of the washing time, the solution was cooled in steps by oscillatory rinsing, then pumped away and twice rinsed with fresh water at a solution ratio of about 1:25.

Comparative Example 4

For comparison, a prior art method was performed with a commercially conventional drum-type washing machine, as follows:

about 1 kilogram = 5 articles of partially heavily soiled men's shirts, of the same quality of material and worn by the same trial group as described under Example 4, were placed in the washing machine and with switching of the programme to "60°C, non-iron" filled to a solution ratio of about 1:25 with fresh water, also of 18° German Hardness. At the same time, 135 grams of a commercially conventional packaged washing agent were poured into the chamber of the rinse-in bowl provided for that purpose. After 15 minutes washing time, in which the solution had reached a washing temperature of 38°C, the solution was pumped out and filled up again with fresh water for the second washing stage, in which, 135 grams of the washing agent were rinsed out of the second chamber. The washing temperature was 60°C and the active washing time 10 minutes. After expiry of the washing time, the same procedure was carried out as in Example 4.

The evaluation of this washing trial was carried out using the evaluation criteria (1) hereinbefore described. The appearance was judged by conferring the remarks "very good", "good", "almost good" and "satisfactory".

After 25 washings:

Method exemplifying the invention

Collars	=	almost good
Cuffs	=	good
Shirt free of spots		
Overall remarks	=	good

Prior art method

Collars	=	almost good
Cuffs	=	almost good
Overall judgment	=	almost good

The evaluation of the various test cloths was undertaken as already described and yielded in tabular presentation:

Testing according to DIN 44 983 Jointly washed test fabric		(Method exemplifying the invention)	(Prior Art Method)
Mixed fabric+, WFK soiled	:	58.7 ± 0.8	49.1 ± 1.4
EMPA	:	45.8 ± 0.8	42.0 ± 0.8
Bleaching intensity	:	23.4	12.4
Greying Wo standard	:	3.3	0.0
Greying Wo towelling	:	7.6	5.8
Degree of whiteness after 25 washings	:	99.0	108.6
Damage factor	:	0.0	0.0
+Mixed fabric cotton:polyester in ratio of 1:1			
Ash standard	:	0.1%	0.2%
Ash towelling	:	0.1	0.1

Deposition of Ca, measured by flame photometry
(Tested after 5, 10, 15, 20 and 25 washings)

Method exemplifying the invention:	Washing operation	5	10	15	20	25
	Ca ppm	490	480	440	480	420
Prior art method:		5	10	15	20	25
	Ca ppm	500	500	510	520	520

It is evident from the test results that, with the method exemplifying and the agent embodying the invention, despite a saving of effective substances and a reduction in the environmental pollution, better results are to be obtained than with the prior art method and agent.

In the following tables, which correspond to examples and comparative examples 1 to 3 above, "Total Washing Time" includes the heating time of the washing solution, and "water" indicates the amount of water added to give the solution ratios stated in the examples and comparative examples. As shown for example in table I, about 10 litres of water were added for the main wash in comparative example I to give a solution ratio of 1:5 with 4 kilogrammes of laundry. Only about 10 litres were required because some of the washing solution remained in the washing machine after the preliminary wash.

TABLE I

(Example 1 and comparative Example 1)

	Washing process - prior art method			Washing process - method exemplifying the invention		
	Temp. (° C)	Total Washing time (minutes)	Water (litres)	Temp. (° C)	Total Washing time (minutes)	Water (litres)
Pre-wash	45	20	about 20	45	20	about 20
Main wash	95	60	about 10	95	60	about 10
1st Rinse	60 approx.			60 approx.		
2nd Rinse						
3rd Rinse		30	about 100		24	80
4th Rinse				15 approx.		
5th Rinse	15 approx.			—	—	—
Spinning		6			6	
Total		116	about 130		110	about 110
Energy (kWh)		3.0 approx.			3.0 approx.	

TABLE 2

(Example 2 and comparative Example 2)

	Washing process - prior art method			Washing process - method exemplifying the invention		
	Temp. (° C)	Total Washing time (minutes)	Water (litres)	Temp. (° C)	Total Washing time (minutes)	Water (litres)
Pre-wash	45	20	about 20	45	20	about 20
Main wash	95	60	about 10	60	50	about 10
1st Rinse	60 approx.			35 approx.		
2nd Rinse						
3rd Rinse		30	about 100		24	about 80
4th Rinse				15 approx.		
5th Rinse	15 approx.			–	–	–
Spinning		6			6	
Total		116	about 130		100	about 110
Energy		3.0 approx.			2.0 approx.	

TABLE 3

(Example 3 and Comparative Example 1)

	Washing process - prior art method			Washing process - method exemplifying the invention		
	Temp. (° C)	Total Washing time (minutes)	Water (litres)	Temp. (° C)	Total Washing time (minutes)	Water (litres)
Pre-wash	45	20	about 20	45	20	about 20
Main wash	95	60	about 20	60	30	about 10
1st Rinse	60 approx.			35 approx.		
2nd Rinse						
3rd Rinse		30	about 100		24	about 80
4th Rinse				15 approx.		
5th Rinse	15 approx.			–	–	–
Spinning		6			6	
Total		116	about 130		80	about 110
Energy (kWh)		3.0 approx.			2.0 approx.	

An embodiment of the washing machine according to the third aspect of the invention will now be more particularly described by way of example with reference to the accompanying drawings, in which:-

Figure 1 is a schematic front end view of a front-loadable drum washing machine embodying the invention, with a front wall thereof removed;

Figure 2 is a side view of an effective substance container in the machine of Figure 1;

Figure 3 is a front end view of the container of Figure 2;

Figure 4 is a sectional view, to an enlarged scale, of the in-feed connection of the container of Figure 2;

Figure 5 is a sectional view of a venting device for the container of Figure 2;

Figure 6 is a schematic back end view of the metering devices and containers in the machine of Figure 1;

Figure 7 is a back end view of one of the metering devices of Figure 6;

Figure 8 is a side view of the metering device of Figure 7; and

Figure 9 is a sectional elevation of the upper front edge portion of a washing machine embodying the invention.

Referring now to the drawings, there is shown in Figure 1 an automatic washing machine comprising a housing 1 with base 2 on which fastening devices 3 for spring legs 4 are provided. The spring legs 4 are connected at their upper ends to a solution container 6 of the washing machine by corresponding fixing devices 5. A drum, which is journalled horizontally in the solution container, is not represented for the sake of clarity. A driving motor 7 for the drum as well as an outflow connection 8 of the solution container are arranged in the lower region of the solution container 6. The outflow connection is connected through elastic pipe ducts with a solution pump 9, the pressure side of which is connected on one side with one side of the pre-mix channel 12 through a switchable water shunting valve 10. The other side of the pre-mix channel has an overflow elbow 13, which opens into a water trap 14 connected to the solution container 6. The fresh water feed duct, controlled by a single valve 15, also opens into this water trap. The plurality of valves, hitherto needed in the case of multi-chambered rinse-in bowls or an additional multi-way water shunting valve, are superfluous.

A plurality of effective substance containers 17 are attached to the pre-mix channel 12 by, for example, six metering devices 16, which are only schematically represented in Figure 1. The effective substance containers 17 are so graded in their size that, according to a statistically distributed frequency of the chosen washing programmes, all containers are emptied after expiry of the planned storage time. The volume-ratio for six containers may be, for example, 8:4:2:1:1:1.

The corner space 46 above the drum-shaped solution container 6 not occupied by the storage and metering device, which space is represented by hatching, can accommodate the switching and control arrangements of the washing machine. The programme control equipment, which is not shown nor described in detail, can also be accommodated in this corner space 46. In washing machines which on the rear side of the cover plate possess a desk structure provided for operating elements, at least parts of the storage devices and/or metering devices can also be accommodated therein.

By way of example, the operating sequence of a washing programme can proceed as follows:

After the machine has been loaded with washing, the valve 15 turns on the fresh water feed duct. The fresh water enters the solution container 6 through the water trap 14 and soaks the washing, whilst the drum is moved with a reversing motion a few times. Insofar as a pre-wash is provided for in the selected washing programme, the water disposed in the solution container can be heated to a low pre-wash temperature. The warmed water is then conveyed into the pre-mixing channel 12 through the solution pump 9 and the water shunting valve 10. At the same time or a short time before, one or more of the washing agent effective substances stored separately in the effective substance containers 17 is or are introduced into the pre-mixing channel 12 in a quantity accurately predetermined by the machine programme, for example, by a pulse length selector controlled by the programme. The circulating warmed water therefore rinses the required quantity of washing agent effective substance into the solution container until it is absolutely certain that all the remnants of the quantity of active substance in the pre-mixing channel 12 have been uniformly distributed in the circulating water. Moreover, the outlet connections opening out into the pre-mixing channel stay constantly wetted and cannot, therefore, clog up. The metered quantity of the required effective substance just suffices to fulfil its task during the pre-wash. So that the water from the pre-mixing channel 12 is not sucked back, due to gravity, in the one or other direction after switching off of the solution pump, ventilation devices (not shown) can be provided at each side of the pre-mixing channels.

The consumed solution can be unreservedly pumped away at the end of the pre-wash

operation through the water shunting valve 10, which is switched over, and through the outlet arrangement 11, since scarcely any unused quantities of effective substances of the washing agent are contained in the waste solution. Therefore, no unnecessarily high consumption of effective substances is developed in the operation of this washing machine and the environment is not polluted more than is unavoidable.

At the beginning of the clear wash, fresh water is again fed in through the valve 15 until a water level required for it in the solution container is reached. After the solution has been heated up to a temperature value predetermined by the machine programme, the solution from the solution container can again be pumped round through the pre-mixing channel 12. Again, definite quantities of one or more effective substances can be introduced into the pre-mixing channel 12 from one or more effective substance containers 17 and conveyed by circulating solution into the solution container 6. After the clear wash, the optimally used solution is conveyed out of the machine through the outlet arrangement 11.

Other washing operations, of which the temperature values and water levels as well as the addition of one or more effective substances are matched to the kind of laundry concerned, proceed correspondingly. By way of example, also during a wash programme, one of the effective substances of the washing agent provided can be used initially at a desired temperature of the solution or at a particular water level before the temperature or the water level are changed, and a further addition of the same or another effective substance can then take place.

Subsequent rinsing operations can be used in the same way, in order, for example to neutralise more quickly the residual alkalinity contained in the laundry with the aid of a measured feeding of an effective substance and to add a soft rinsing agent or the like to the laundry.

The effective substance container schematically represented in Figures 2 and 3 consists of, for example, a transparent synthetic material which is resistant to all the effective substances used and which has at its end face turned towards the metering device a feed connection 18, which is situated at the lowest part of the horizontally inserted container. This lowest part is so constructed that the residual quantity of the contents remaining therein when the container is emptied is as small as possible. Moreover, provided in the feed connection is a device (not shown) which on withdrawal of the container closes off the interior space outwardly, so that no remnant of the effective agent can issue inadvertently. The feed connection so points to the metering device associated therewith that, on the introduction of the effective substance container into the device (not shown) provided to receive it, it is automatically penetrated by a hollow pin 19, which is shown in more detail in Figure 4. A small membrane 20, which seals off the feed connection 18 before the introduction of the container, is in that case pierced by the obliquely cut-off hollow pin 19. Furthermore, the inserted hollow pin can serve to open the outflow prevention device (not shown).

In a position some distance above, there is a ventilation connection 21, which in the unused state of the container is also sealed off by a small membrane. On introduction of the container, its membrane can also be pierced by a hollow pin, shown by way of example in Figure 5. So that the ventilation connection 21 does not produce a constant connection of the inner space of the container to the outside air, a simple non-return valve is arranged in the ventilation pin (Figure 5), through which the inner space of the container can draw in external air but no steady exchange between external and internal air occurs. Otherwise, there is the danger of the content of the container drying out, jelling or crystallising during a longer period of use. The feed and ventilation connections 18 and 21 of the effective substance containers can, however, be replaced by other suitable constructions.

The effective substance containers 17, arranged beside one another, are represented in Figure 6 from the rear side of the machine. For better clarity, the ventilation pins (Figure 5) are not shown here, so that only the ventilation connections 21 are to be seen. For the same reason, the pre-mixing channel arranged in front of the metering devices is omitted. The metering devices 25 are arranged in front of the feed connections of the effective-substance containers 17. In the example, they each consist of a pump body 26 with a hollow pin 19 and an outlet connection 27 as well as a respective belt pulley 28. A driving belt 29, which encircles the belt pulleys 28 of all the metering devices, is further connected with a similar belt pulley 30 of the common drive motor 31. As soon as this motor runs, all belt pulleys 28 are moved. The belt 29 can be a simple flat belt or a toothed belt, which latter, because of complete freedom from slip, is of greater advantage for the more accurate metering of the effective substances of the washing agent. Deflecting rollers 32 are provided for enlarging the looping angle at the belt pulleys. With the use of a friction belt, such guide rollers can be dispensed with when the friction belt loops around the belt pulleys alternately in the right and left hand directions.

Figures 7 and 8 show a single metering device 25, in the pump body of which is arranged a

gear pump with toothed wheels 33 and 34 running in two compartments. The hollow pin 19 is connected to the suction side of the gear pump and to the pressure side is connected the outlet connection 27 which, together with the outlet connections of the other metering devices, opens out into the pre-mixing channel 12.

The gear pump is drivable through a coupling, which consists of two wheels 35 and 36, which are permanently disposed in engagement with one another and the axes 37 and 38 of which are connected with swivellable arms 39 and 40. Whilst the axis 38 is unrotatably connected with the toothed wheel 33 and the coupling wheel 36, the wheel 35 can move on its axis 37 in rotational direction. The arms 39 and 40 are unrotatably connected with the axis, but can, however, be freely swivelled about the axis 38. The bearing of the wheel 35 is engaged by the axially sprung plunger 41 of a relay armature 42, the electromagent 43 of which is energised by the programme control equipment at the instant of the desired addition of the washing agent effective substance for a time corresponding to the quantity to be metered. This time corresponding to the metered quantity can, for example, be provided by a pulse length selector, for the control of the coupling and controlled by a cam of the programme control equipment. With a suitable design of the pulse selector, the time can also be variable. The bearing of the wheel 35 is further engaged by a return spring 44, which pulls the arms 39 and 40 back into the illustrated rest position. In the operating position, shown by dash-dotted lines, the wheel 35 engages into a drive wheel 45 (Figure 8), which turns with the belt pulley 28. These wheels can be constructed as friction wheels or as toothed wheels. For the afore-mentioned reason, however, toothed wheels are recommended for this purpose.

The represented embodiment has been described with reference to a front-loadable drum washing machine. The washing machine can, however, readily be a shell-loadable drum washing machine. It is also possible to arrange the storage and metering devices in a sufficiently large space beneath the solution container when the other equipment assigned to this space (drum motor, solution pump, temperature switch, etc.) are concentrated in a smaller space. Moreover, a desk construction, which may be provided for the operating elements of the washing machine, could also serve as accommodation for the effective substance containers. The desk construction could contain the entire control apparatus. The corner space 46 (Figure 1) can then be used for further effective substance containers. The washing machine could, however, be any other kind of automatically operating washing machine in which the laundry to be washed is moved relatively to the washing solution.

Furthermore, the proposed washing machine can be used for the method according to the invention when the fresh water feed duct opens not into the water trap, but directly into the pre-mixing channel. The additional water shunting valve 10 and the rinsing duct from this to the pre-mixing channel can then be dispensed with. Insofar as the washing machine is additionally connectable to a hot water feed, the possibility of rinsing in the effective substances of the washing agent by hot water can be retained.

With the use of a water trap 14, as shown in the described embodiment, an air feed and air ventilation (not shown) is expediently provided, since otherwise the compression or rarefaction of the air on a change of the temperature and filled quantity of the solution container would have to equalise through the water trap.

Instead of a water shunting valve 10 in the waste solution channel, an additional circulating pump can be provided for the rinsing duct leading to the pre-mixing channel 12. The additional pump can be arranged beneath the solution container 6. On the use of a self-priming circulating pump, this can be arranged at the entry of the rinsing duct into the pre-mixing channel. In this case, it is particularly advantageous for each metering device to be made couplable to the motor provided for the circulating pump. The circulating pump and the metering devices can thereby be integrated into a contiguous body and operated in common functional dependency.

For the case in which fixed built-in effective substance containers are used instead of the interchangeable effective substance containers described in the embodiment, the same arrangement of the containers and the metering devices can be chosen. In that case, the construction of the connection between the containers and the metering devices as a hollow pin can be dispensed with. Instead, fixed connections can be provided. Furthermore, withdrawable filler connectons disposed in the upper region of the machine can expediently be arranged for each container and can be concealed behind a cover flap when not in use.

For this purpose, the wasing machine can be provided at its front side, as shown in Figure 9, with several apertures 50, which are normally concealed or filled in by covers 51. The cover 51 can be articulatedly attached to the front side of the machine housing 1 or can be rigidly connected with a filler 52, which can be pulled out and which at its upper side carries a filling pipe 53 with an external thread. A transportable replenishment container (not shown) can be screwed onto the pipe 53 by means of a correspondingly threaded outlet of

the container. After discharge of the effective substance into the pipe 53, the filler 52 is pushed back into the interior of the housing 1 so that the cover 51 is aligned with the front side of the housing.

The individual metering devices 25 shown in Figure 6 could, of course, be arranged in the form of a unitary body. It can be expedient in this case to integrate the drive motor 31 therein and optionally also to couple all couplings through a unitary toothed-wheel gearing or through their arrangement on a single shaft. The latter feature can be realised if the metering devices, in contrast to the embodiment hereinbefore described, are arranged not side by side, but one behind the other and with their side surfaces pointing to the component containers. The structuring of the couplings is left to the constructor. The example shown in Figures 7 and 8 has been chosen only for the purpose of simpler explanation.

Should future designs of small motors prove to be smaller and/or cheaper in comparison with couplings with a common drive motor, then a separate motor without switchable coupling can be provided for each metering device.

WHAT WE CLAIM IS:-

1. A method of washing textile articles in an automatic washing machine, comprising the steps of adding water to an automatic washing machine charged with textile articles to provide a wash having a weight ratio of textile articles to washing solution of 1:4 to 1:30, withdrawing from respective storage means metered quantities of effective substances or combinations of effective substances in pumpable form, the effective substances comprising 0.5 to 3.5 grams of active washing substances per litre of the washing solution and 2.0 to 6.5 grams of builder substances per litre of the washing solution, adding the metered quantities to the washing solution before or during the washing process, agitating the textile articles in the washing solution during an active washing time of up to 50 minutes, removing the washing solution from the machine after the active washing time, and then rinsing the textile articles 2 to 5 times.

2. A method as claimed in claim 1, wherein the effective substances further comprise a stabilised bleaching agent.

3. A method as claimed in claim 2, wherein the stabilised bleaching agent is added to the washing solution during the active washing time in an amount of 0.1 to 0.5 grams per litre of the solution.

4. A method as claimed in either claim 2 or claim 3, wherein the effective substances further comprise a catalyst to accelerate decomposition of the bleaching agent.

5. A method as claimed in any one of the preceding claims, comprising the further step of adding to a rinsing solution for rinsing of the textile articles a metered quantity of at least one organic acid in pumpable form.

6. A method as claimed in claim 5, wherein the organic acid or acids is or are added to the rinsing solution during the rinsing step in an amount of 0.02 to 0.1 grams per litre of the rinsing solution.

7. A method as claimed in any one of the preceding claims, comprising the further step of adding to a rinsing solution for rinsing of the textile articles a metered quantity of a soft rinse agent in pumpable form.

8. A method as claimed in claim 7, wherein the soft rinse agent is added to the rinsing solution during the rinsing step in an amount of 0.1 to 0.5 grams per litre of the rinsing solution.

9. A method as claimed in any one of the preceding claims, comprising the further step of setting the machine to a predetermined washing temperature.

10. A method as claimed in any one of the preceding claims, wherein said steps of adding the water and withdrawing and adding the metered quantities, agitating the textile articles, removing the washing solution and rinsing the textile articles are carried out as a main washing process, and the method further comprises carrying out before the main washing process a preliminary washing process comprising the steps of adding water to the charged washing machine to provide a wash having a ratio of textile articles to washing solution of 1:4 to 1:30 by weight, adding to the washing solution 0.5 to 1.5 grams of active washing substances per litre of the washing solution and adding to the washing solution builder substances, setting the washing solution to a temperature of up to 60°C, agitating the textile articles in the washing solution and then removing the washing solution from the machine, the active washing substances and the builder substances being added to the washing solution of the main washing process in amounts of respectively 0.5 to 2.0 and 1.0 to 3.5 grams per litre of the solution and the washing solution of the main washing process being set to a temperature of up to 95°C.

11. A method as claimed in claim 10, wherein the preliminary washing process further comprises the step of adding to the washing solution 1.0 to 3.0 grams of builder substances per litre of the washing solution.

12. A method as claimed in either claim 10 or claim 11, wherein the washing solution of the main washing process is set to a temperature of up to 60°C.

13. An agent for use in the method as claimed in claim 1, comprising a combination of effective substances in pumpable form, the effective substances being separate from one another in packages suitable for the household and comprising at least an active washing substance and a builder substance in amounts of respectively 0.5 to 3.5 parts by weight and 2.0 to 6.5 parts by weight, the active washing substance in the combination comprising 20 to 25% by weight of linear chain alkylbenzolsulphonate-Na-salt (C_{10} to C_{13}), 100%

1.2 to 1.8% by weight of toluolsulphonate-Na-salt, 100%
8.0 to 9.5% by weight of hardened tallow-fat-acid-Na-soap,
12.5 to 16.5% by weight of tallow-fat alcohol with 11 ethylene oxide,
9.5 to 13.0% by weight of isopropanol, and
0.3 to 0.5% by weight of NaOH, the remainder being water with usual impurities and of 1 to 14° German Hardness.

14. An agent for use in the method as claimed in claim 1, comprising a combination of effective substances in pumpable form, the effective substances being separate from one another in packages suitable for the household and comprising at least an active washing substance and a builder substance in amounts of respectively 0.5 to 3.5 parts by weight and 2.0 to 6.5 parts by weight, the active washing substance in the combination comprising

13.0 to 17.0% by weight of olefinsulphonate-Na-salt (C_{16}–C_{18}), 100%,
30.0 to 35.0% by weight of oleyl alcohol + 10 ethyleneoxide + 3 propyleneoxide,
2.0 to 4.0% by weight of hardened tallow-fat-acid-Na-soap, and
9.0 to 11.0% by weight of isopropanol, the remainder being water with usual impurities and of 0 to 14° German Hardness.

15. An agent as claimed in either claim 13 or claim 14, wherein the builder substance in the combination comprises

35.0 to 40.0% by weight of potassium tripolyphosphate,
0.8 to 1.8% by weight of sodiumtrisilicate (water glass, 100%), and
0.5 to 0.9% by weight of NaOH, the remainder being water with usual impurities and of 0 to 14° German Hardness.

16. An agent as claimed in either claim 13 or claim 14, wherein the builder substance in the combination comprises

44.0 to 47.0% by weight of Na-Nitrilotriacetate,
0.8 to 1.6% by weight of sodium silicate (waterglass, 100%), and
1.0 to 2.0% by weight of NaOH, the remainder being water with usual impurities and of 0 to 14° German Hardness.

17. An agent as claimed in any one of claims 13 to 16, further comprising a stabilised bleaching agent in the combination.

18. An agent as claimed in claim 17, wherein the bleaching agent is present in the combination in an amount of 0.1 to 0.5 part by weight.

19. An agent as claimed in either claim 17 or claim 18, wherein the bleaching agent comprises

5.0 to 10.0% by weight of hydrogenperoxide, 100%, and
0.1 to 0.15% by weight of dipicolinic acid, the remainder being water with usual impurities and of 0 to 14° German Hardness

20. An agent as claimed in any one of claims 17 to 19, further comprising a catalyst in the combination for accelerating the bleaching process.

21. An agent as claimed in claim 20, wherein the catalyst is present in the combination in at least a stoichiometrical quantity relative to the bleaching agent.

22. An agent as claimed in either claim 20 or claim 21, wherein the catalyst is N-acetylcaprolactam.

23. An agent as claimed in any one of claims 13 to 22, further comprising an organic acid as an effective substance in the combination.

24. An agent as claimed in claim 23, wherein the organic acid is present in the combination in an amount of 0.02 to 0.1 part by weight.

25. An agent as claimed in either claims 23 or 24, wherein the organic acid comprises

2.0% by weight of citric acid,
0.2% by weight of lactic acid, and
0.2% by weight of acetic acid, the remainder being water with usual impurities and of 0 to 14° German Hardness.

26. An agent as claimed in any one of claims 13 to 25, further comprising a soft rinse agent as an effective substance in the combination.

27. An agent as claimed in claim 26, wherein the soft rinse agent is present in the

combination in an amount of 0.1 to 0.5 part by weight.

28. An automatic washing machine for carrying out the method as claimed in claim 1, comprising a housing, washing-programme control equipment, at least one valve-controlled fresh water feed duct, a solution pump, a solution container, a plurality of metering devices, which are arranged in the housing, are selectively controllable by the programme-control equipment and which are each adapted to meter a respective one of a corresponding plurality of separate effective substances or combinations of effective substances of an agent, each metering device being provided with an inlet directly connected with an outlet of a container for the respective effective substance or combination and provided with an outlet directly opening into a common premixing channel connected with the solution container, and drive means so drivingly couplable to the metering devices as to drive any one or any combination of the devices.

29. A washing machine as claimed in claim 28, wherein the channel is connected with the solution container through a water trap.

30. A washing machine as claimed in either claim 28 or claim 29, wherein the effective substance containers are detachably mounted in the housing to be removable from the machine in a given direction and the outlet of each effective substance container is so arranged at a side thereof facing the associated metering device and at the lowest portion of that container as to extend parallel to the given direction, each of the effective substance containers being provided with an air vent adapted to prevent the exhaustion of air from such container.

31. A washing machine as claimed in claim 30, wherein each of the metering devices is provided at its inlet with piercing means to pierce a membrane sealing the outlet of the associated effective substance container.

32. A washing machine as claimed in claim 28, wherein the effective substance containers are fixedly mounted in the housing and are each provided with a filler inlet.

33. A washing machine as claimed in any one of claims 28 to 32, wherein each of the metering devices comprises a gear pump couplable by means of a respective electrically operable coupling with a drive motor of the drive means.

34. A washing machine as claimed in any one of claims 28 to 33, wherein the premixing channel is connected with the pressure side of the solution pump and with an overflow elbow connected by a water trap with the solution container.

35. A washing machine as claimed in claim 34, wherein the fresh water feed duct is connected to the water trap by means of a hydraulic jump.

36. A method of washing textile articles, substantially as hereinbefore described with reference to any one of Examples 1 to 4.

37. An agent as claimed in either claim 13 or claim 14 and substantially as hereinbefore described.

38. A washing machine substantially as hereinbefore described with reference to the accompanying drawings.

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1569697 COMPLETE SPECIFICATION

4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

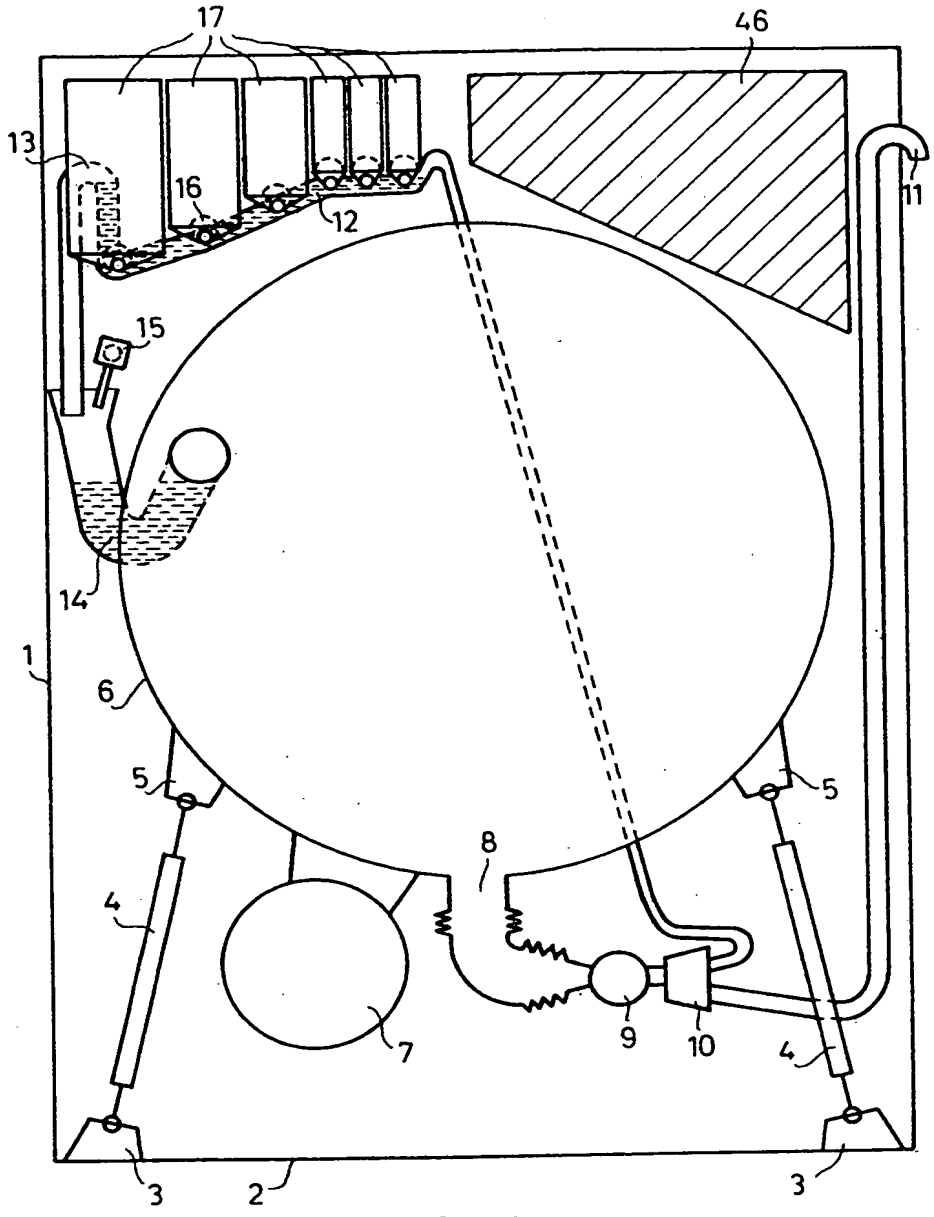


Fig.1

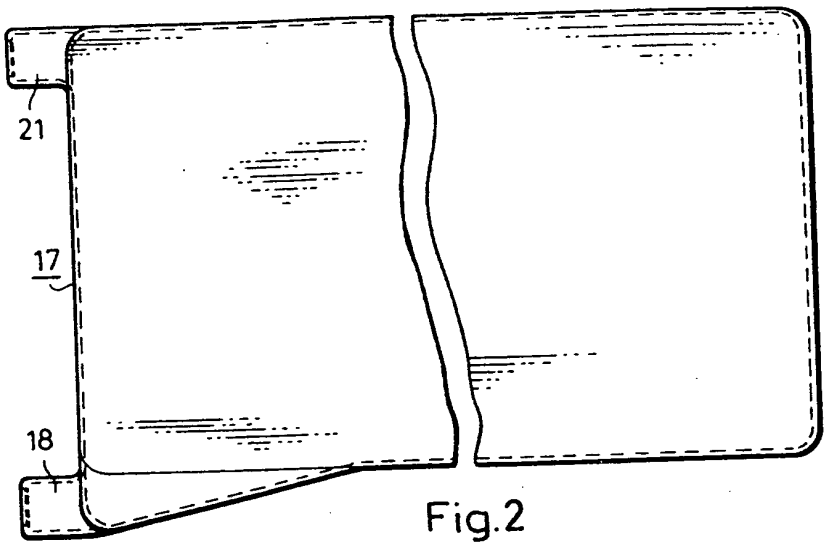


Fig.2

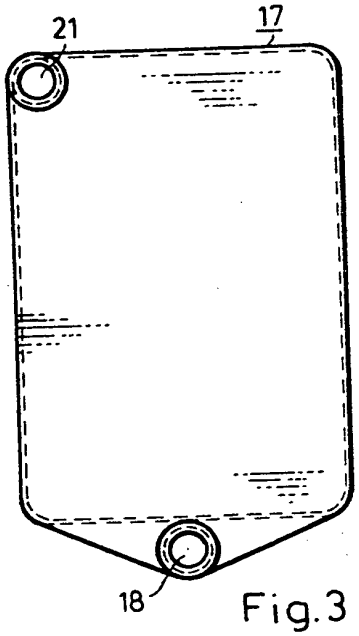


Fig.3

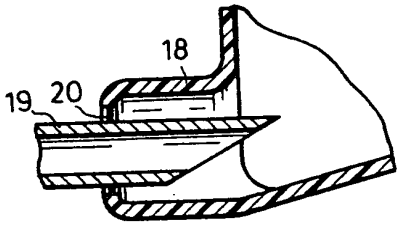


Fig.4

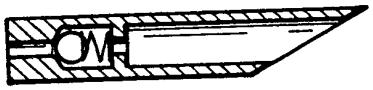


Fig.5

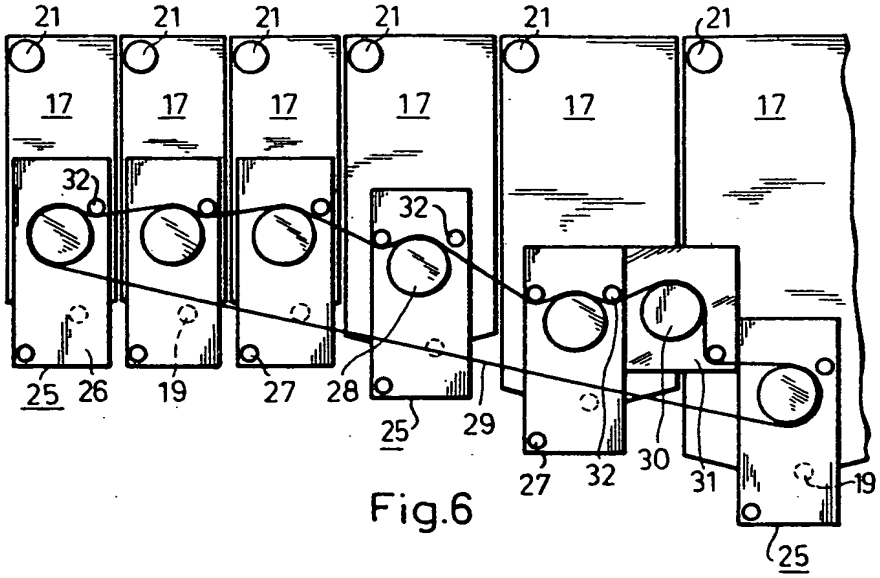


Fig.6

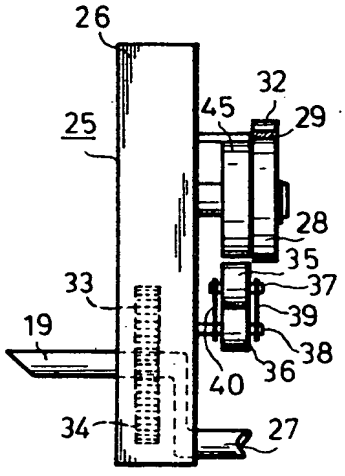


Fig.8

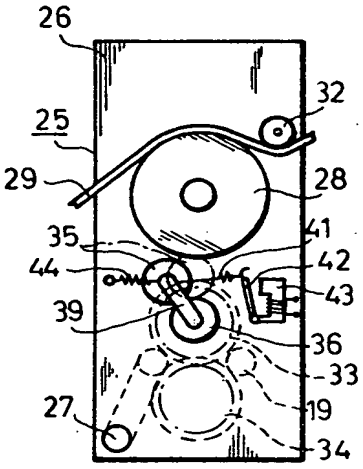
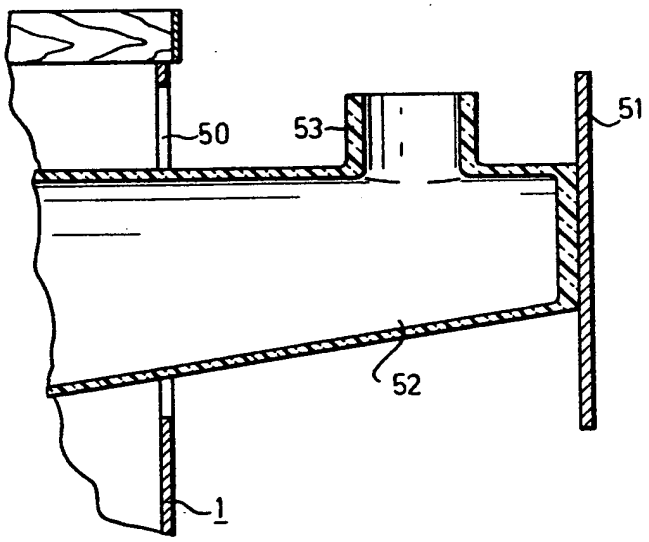


Fig.7

1569697 COMPLETE SPECIFICATION
4 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 4

Fig. 9



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